







### REMARKS

ON THE

## GASEOUS OXYD

OF

# AZOTE OR OF NITROGENE,

AND

ON THE EFFECTS IT PRODUCES WHEN

GENERATED IN THE STOMACH, INHALED INTO THE LUNGS, AND APPLIED TO THE SKIN:

BEING

AN ATTEMPT

'TO ASCERTAIN THE TRUE NATURE OF

CONTAGION,

AND

TO EXPLAIN THEREUPON THE PHENOMENA OF

FEVER.

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# PREFACE.

IT has a long time appeared to me highly probable, that contagion was an aëriform fluid, produced occasionally, and exercising for a season its destructive effects. Since my appointment to the Professorship of Chemistry in the College of New-York, my mind has been particularly engaged in acquiring as full a knowledge as I could of the gasses. In the course of my experiments and inquiries, I have become fatiffied my original conjecture was right; and I have to acknowledge the pneumatic philosophy has led the way to an elucidation of this hitherto dark and intricate subject. The combination of the base of vital air with the radical of nitrous acid forms a compound which, though little known, possesses very remarkable qualities. If A 2 the

the principles laid down in the following pages are true, a considerable number of interessing deductions may be drawn from them, both in the theory and practice of physic, and in relation to health offices and the means to be adopted for guarding against infectious distempers. Under the persuasion, that the mode of considering this subject is novel, the performance is submitted to the consideration of the public. My fellow citizens, for whom it was written, will learn how much the preservation of health is in their own power.

Plandome, August 20, 1795.

## REMARKS

ON THE

# Gaseous Oxyd of Azote, &c.

THIS is the air mentioned by Priestley (ii. Exp. & Obs. 54, &c.) under the title of Dephlogisticated Nitrous Air. He discovered it by exposing nitrous gas to iron, whereby that aëriform fluid was transformed in about two months to a species of gas of a very remarkable kind, "which keeps up combustion naturally and freely in a candle immersed in it, but is at the fame time highly noxious to animals, and destroys their life the moment they are put into it:" whereas it commonly happens, that animals can live tolerably well in air so vitiated by inflammation, that a candle will no longer burn in it.

He obtained this air too by applying heat to a diffolution of iron in nitrous acid, after the production of nitrous gas was finished; in a direct process by the dissolution of zinc and tinin nitrous acid; by exposing nitrous gas to a mixture of iron filings and sulphur moistened with water, and to hepar sulphuris; and likewise by iron and solution of copper in the ni-

trous acid.

He found, that when phlogisticated air (nitrogene or azotic gas) and dephlogisticated nitrous air (gaseous oxyd of nitrogene or azote) were mixed together, it was an easy matter to separate them by means of water; for the latter, by reason of its readier miscibility with water, will combine with that fluid in a very pure form, while the former will remain unabsorbed.

Prieftley's speculations concerning the confitution of this air are attended with all the difficulty which befets the doctrine of phlogifton; and its true composition seems not to have

been detected until since he wrote.

In the fecond number of the Recherches Physico Chymiques, published at Amsterdam, an account is given, which confirms the facts related by Priestley. For this gaseous oxyd was obtained by exposing nitrous gas for three days over water to the action of wetted iron filings; by the subtraction of part of the oxygene of nitrous gas; by the moistened sulphures of potash and soda; by the muriate of tin; and by animoniac with a bit of copper in it: it is related alfo, that folutions of iron and tin in extremely diluted nitric acid, afford this gaseous oxyd, and that the nitrate of ammoniac heated after mixture with three times it quantity of fand, gives toward the end of the operation a large quantity of it.

One of the most happy discoveries of modern science is that of the principle of acidity or oxygene being capacitated to afford products possessing very different qualities, by combining in greater or less proportion with the same

radical.

radical. Thus, for example, azotic or nitrogene gas constitutes  $\frac{70}{100}$ th parts of our atmosphere. Simple nitrogene, the base of this gas, is capable of combining with the principle of acidity as well as the matter of heat (caloric) in four distinct proportions. Azote, in its highest degree of oxygenation, forms nitric acid; in its next, it constitutes nitrous acid; in a lower, nitrous gas; and in the fourth or lowest degree it affords the compound, now more particularly under consideration, the gaseous oxyd of azote, of nitrogene. We hence know, with the utmost certainty, that oxygene, or the base of respirable air, which composes the remaining  $\frac{20}{100}$ th parts of the atmosphere, is in many processes blended with azote in various quantities.

In the gaseous oxyd, produced by the union of these two atmospheric ingredients, the portion of these two atmospheric ingredients, the portion of the acidifying principle combined with its nitrogene base is too small to manifest the smallest degree of acidity; not even so much as to have any effect wrought upon it by exposure to liquid caustic alkali, nor muriated tin; and in its pure state undergoes no shrinking, decomposition, or change, by mixture with the atmospheric sluid, nitrous gas, or vital air.

The properties of this oxydare so singular and extraordinary, that Priestley affirms, (ii. 55.) at the time of his sirst publication on the subject, he should not have hesitated to pronounce them impossible; to wit, a power, at the same time, of supporting slame, and of extinguishing life. This surprising quality is however doubtless owing to the difference in the attractive force which

which its oxygene exerts for hydrogene in the one case, and for carbone in the other; for it is known, that by mixing the gafeous oxyd of nitrogene with carbonated hydrogene gas, the carbone is precipitated from its folution. Hence it appears, that the attraction for charcoal is much weaker than for hydrogene, and that although carbone may be made to burn in the gafeous oxyd, hydrogene is the substance for which it has the closest affinity. And we can now readily conceive how the hydrogene of the candle may, in an especial manner, contribute, by attracting the principle of acidity from the gaseous oxyd, to keep up the inflammation, wherein some part of the charcoal may likewife, though in a fecondary way, be converted to carbonic gas. It may be understood too, wherefore it is not capable of fustaining life. There are two important purposes answered by animal respiration; the one to furnish oxygene to the phosphoric, sulphureous and carbonic matter of the blood; the other to carry off its furplusage of charcoal by means of the lungs. Now the gaseous oxyd has less action upon phosphorus and sulphur than it has upon charcoal. Hence it is a very natural conclusion, that in ordinary breathing, the gafeous oxyd does not only not yield its principle of acidity to the blood in the pulmonic circulation, but at the same time does not sufficiently attract carbone from the venous portion of it; whence it comes to pass, that an animal inhaling an air, contributing to neither of these falubrious pro-cesses, must speedily die; its blood being both

in a difoxygenated and fuper-carbonated state; hydrogene alone being the ingredient in phlogistic operations which readily attracts its oxygen from the gaseous oxyd.

The proportion of oxygeneentering into gaseous oxyd is  $\frac{370}{100}$ ; the other 63 parts being nitrogene; whereas in nitrous gas, the oxygene con-

stitutes 68 parts of the 100.

On reflecting upon these facts, it occurred to me this subject merited consideration in se-

veral other points of view: As,

1. Since this remarkable aëriform product is afforded by a variety of artificial processes, whether it is not generated likewise by a natural operation in the decay of organized bodies, containing both nitrogene and oxygene?

The history of nitre throws great light upon this query. That substance is known to confift of nitrous acid joined to pot-ash. It is usually formed during the decay of animal and vegetable bodies, and by a spontaneous process, is produced from their ruins. We are quite fatisfied that azote and oxygene entered into the composition of those bodies when alive, and have gone into new combinations on their disengagement by death. One of these recent compounds must be nitrous acid, constituting by junction with a faline base, the nitrate of pot-ash. Thus, the theory of the formation of falt-petre necessarily presumes the generation of nitrous acid from two of the elements disengaged from organic texture. And as azote, the radical of the acid, is especially abundant in animal bodies, and as Lavoisier (i. Traité elementaire

mentaire de Chimie, 155.) fays, favorife merveilleusement la putrefaction, wonderfully promotes putrefaction, there is little difficulty in conceiving, both how in such circumstances it attracts the acidifying principle, and afterwards attaches itself to the alkali.

But further than this, the authority of Mr. Becker (Notes to Bergman's Elective Attractions, 327.) has been advanced in favour of the production of nitrous acid without the aid of the putrefactive fermentation at all. He found nitrous-acid in the urine of cows, which had been eight days exposed to the fun. He mixed some of the foakings of a dunghill with a ley of burnt flieep's dung and chalk in powder. The mixture began to ferment on the following day, and on the fourth, the internal commotion having ceafed, he found at the bottom of the phial regular chrystals of prismatic nitre. He ascribes the nitrous acid not to a process going on in the air, but brought about by the excretions of animals. On examining the earth of stables and cow-houses, he found its lixivium to yield prismatic nitre, while that of the dung would afford only small chrystals, which required an addition of nitre in order to be reduced to a prismatic form; and he declares he can attract falt-petre at pleasure, in the course of three days, from the earth of stables and cowhouses, by using for faturation well-purified pot-ashes.

In the production of falt-petre, the putrefied fubstance, if of the animal kind, affords little more than the nitrous acid. This was known

fays, the nitrous quality of the earth is derived from the excrements of animals and their putrefied carcafes, particularly fuch as do not use sea-falt, as birds, which, by the addition of the assessment of plants and

of quick lime, forms falt-petre, &c.

This fact of the animal origin of the nitrous acid is confirmed by the testimony of MACQUER, (iii. Dictionaire de Chimie, 18.) who declares, that in the putresactive process which affords nitrous acid, animal substances have a decided preference; so that, in order to make chrystalizable salt-petre from substances purely animal, a quantity of the vegetable alkali must be added; while the salt-petre produced in the putresaction of vegetables alone is naturally sound to be surnished with that quantity of fixed alkali which

is necessary to form good nitre.

To this may be added the authority of Fourcroi, (ii. Lecon Elementaires, &c. 842.) who fpeaks of acidity as one of the early figns of animal putrefaction; and of the proper putrid exhalation as not to be confounded with carbonic acid, (fixed air) hydrogene gas, (inflammable air) which are at the fame time let loofe, nor with the phofphoric emanation which fometimes glows on the furface of corrupting animal folids. When to all this it is fubjoined, that on analizing the foil taken from the bottoms of graves where human bodies have putrefied, it has been found, though having no communication with the external air, to be highly charged with ni-

trous acid, the animal origin of this acid is put

entirely out of doubt.

We hence fee the reason why the French chemists have advised the use of wood ashes to neutralize the redundant nitrous acid in their salt-petre works, and have even gone so far as to recommend foreign pot-ash as greatly preserble. On this subject, the valuable paper of Mr. Massey may be consulted in the Memoirs of the Manchester Society, where it is made to appear, that earths become impregnated with nitrous acid during the putresaction of animal substances, but will not afford a crystal of nitre until the vegetable alkali is added.\*

In

\* It is a pity, that notwithstanding all these things, the French Academicians who framed the new Nomenclature, suffered themselves to retain the words nitrous acid, nitrous gas, &c. which seem to me to be very improper, and to be quite as subject to objection as the terms azote and nitrogene, for their radical. The mind becomes unhappily impressed with the notion of those products being derived from nitre, whereas the sact is, nitre derives its origin from this animal acid. Had I been a member of that committee of the academy, I should have proposed to derive the name of the radical from the Greek werb on ma, putresacio; to call it on more youtridum; and have made the Nomenclature standthus:

Septon; in-Gaseous oxyd of Septous gas; Septic gas; Read of ainstead of fepton; instead of instead azotic gas or galeous oxyd of zote or niazote or of nitrogene. nitrogene nitrous gas. trogene. gas.

In these several ways, we find nitrous acid afforded by the putresaction of animals themselves, and by changes in their excretions. Now, nitrous acid, differing from the gaseous oxyd, barely in the degree of oxygenation, there is no difficulty in comprehending, that if there was in any instance a spontaneous formation of the former, there would, a fortiori, be a more easy and frequent production of the latter.

And here it happens, that the very thing which reason seeks for, nature affords. That particular gas, described by Mr. St. John (Presace to Method of Chemical Nomenclature, xi.) as produced at certain times during the putresaction of human bodies in dissecting rooms, and as being a most active and dreadful poison, is, in all probability, the very acrisform product which is the subject of this memoir. That exhalation is not only incapable, in its concentrated condition, of sustaining life, but, like the gaseous oxyd, though it may be rendered less injurious

Septous acid; Septic acid; Septate; instead of instead of septite, &c. nitrous acid. nitric acid. &c. and then, the original of the thing, being always suggested to the mind in the phraseology, truth would have found a more ready reception, and no such difficulty interposed as now besets us, prepossessed are with the notion, that the nitrous is a mineral acid. For it should be remembered, that although it is obtained from nitre, a salt classed among the mineral substances, yet it was produced by animal putres thion before the nitre was formed.

injurious by dilution, does not however change its original virulence in the least, by the prefence of the atmospherical fluids; and, like the gaseous oxyd too, it is not remarkable for any fector or particular badness of smell; both of them differing entirely from the loathsome and nauseous odour proceeding from dead bodies in a less dangerous stage of corruption.

The deleterious production, so particularly mentioned by Mr. Fourcroi, in his report on the removing the Cimiterié des Innocens at Paris, and now and then fatal to the gravediggers, appears to be a gas of precisely the same origin and qualities, and as in the former

instance, is generated in the abdomen.

The gaseous oxyd of nitrogene in these instances is always, as far as observation goes, of local origin, and feldom spreads very far in form sufficiently condensed to do mischief. In large cities it is generally most abundant, by reason of the greater collection, along some of their streets, fewers, wharfs, docks, &c. of those materials, which afford it, and, on account of the difficulty of ventilation, in certain lanes, yards and alleys, which allows the noxious vapour to fettle there. In few instances that I have heard of, has it extended over a large tract of country; in the greater number of cases, it invades but a limited part of a large city, and that only, when a temperature of the weather, between 75 and 85° of Farenheit's scale, favours the formation of the oxyd.

When applied to a living body, fresh and strong on its first formation, it produces violent

inflammation

inflammation and ulceration of the fingers or hand which come in contact with the body from which it proceeds; or drawn into the nof-trils, it excites alarming tumcfaction, with heat and pain in the fauces and nares; or, if infpired fully into the lungs, it brings on instant death.

2dly. If the first question is satisfactorily decided in the affirmative, where large masses of animal and vegetable matter, in hot seasons and confined places, undergo resolution into their constituent parts, and form new combinations; then is it not presumeable that gaseous oxyd may be extricated from similar materials by like causes, occasionally, in the alimentary canal, or primæ viæ of human bodies while alive?

For the support of animal life, it is necessary that supplies of food be, from time to time, received into the stomach. The ingredients of diet are of the animal and vegetable kinds, and confequently contain all the materials, after their introduction into the body, that are proper to fimilar fubstances out of the body. And were it not for the mixture with faliva, gastric liquor, pancreatic juice and gall, these alimentary matters would, from the operation of conflant heat and moisture, undergo putrefactive alterations in the stomach and small intestines. By the operation of these animal fluids, the nutritious part of the aliment is dissolved, and prepared for undergoing the process of animalization. For it is to be remarked, that no living thing in the perfectly healthy state exists in the animal stomach; the destruction of life, even in oysters,

oysters, fishes, frogs, &c. swallowed entire, being a preparatory step to their conversion into nutriment; and worms and other animals infessing the guts, being enabled to live there only by possessing a constitution capable of counter-

acting the digestive process.

Nobody has affirmed, that in the animal intestines, the fluids are endued with animation, any more than the aliment they contain. Our reasoning then concerning the whole contents of the first passages, cannot be governed by the laws which regulate animated fustens, but must proceed according to the rules governing the decomposition of organic bodies in such circumstances. Chemical investigation here meddles not with living nerves and fibres, whole functions are not to be interpreted by its aid, but limits itself to the watching into what new forms the inanimate parts of plants and animals are changed after introduction into the belly; a subject on which it is certainly competent to decide. It has been confidered, that in-ordinary cases, the solution of food in the gastric fluid regularly takes place, and the difcovery has been acknowledged to be one of the happiest which physiology has to boast of. Beyond this, our inquiries are very little fatisfactory; and the intestines, though so essential to health, and so frequently the seat of disease, have, in the midst of much curious research, been strangely overlooked. If, in consideration of their containing inanimate fubstances. prone to undergo the putrefactive process, it can be shewn, that the causes usually preventative thereof are, during certain seasons, suspended or weakened, then it will be evident that changes may take place within the intestines, correspondent to those which go on without them, and that similar productions will slow from the one which are known to characterize the other.

Sydenham, (continual fever of the year 1661 and feq.) fays, "he would give an emetic in the "beginning of that fever, that the fick might be preferved from those dreadful fymptoms that arise from the filth of those humous that "lurk in the stomach and neighbouring parts, &c." and seems to have a good general idea of the noxious quality which the contents of the guts sometimes possess. In his account too of the petilential sever and plague which raged in London in 1665 and 1666, he enumerates "violent vomitings, a pain about the region of the heart, as if it were oppressed, and a burning sever," among the earliest symptoms.

Huxham, (Essay on Fevers, chap. viii.) deferibing the symptoms of the severs which he terms putrid, malignant, and petechial, mentions, that together with "head-ach and giddimess, nausea and voniting are much more confiderable than in the slow nervous sever, even

" from the very beginning."

In short, in the collected opinions of those physicians, whom Mr. Howard consulted on the plague, as prevailing in the south of Europe and in Asia, (Account of Lazarettos) dryness of the tongue, veniting, hierarch, nausea, loss of strength and sever, are enumerated among the first symptoms.

B 3 Indeed,

Indeed, the observation of any physician of much practice, in complaints of these kinds, as well as in the yellow sever, bilious sever, &c. is sufficient in satisfying him, without recurring to written authorities, that the diseased state of the alimentary canal is not only one of the first group of symptoms that attract his notice, but is of the most troublesome and dangerous nature too.

It has been doubted what could be the cause of fo much diffurbance in the stomach and bowels. The diforders incident to these are peculiar to animals, and are derived from the necessity we are under, because of our locomotive faculty, of carrying a quantity of manure constantly within us; on which account our organization in this particular differs exceedingly from the vegetable creation, who have their food brought them, but are under no need of taking the crude mass within them. If vegetables then have no analogous ailments, it must be owing to their inhaling their chyle from their external furface, and the inconvenience experienced by animals, be referred to their taking into their bellies a good deal of matter beyond what is convertible to nourishment, and carrying the fœculent collection about with them. Qur locomotive power is indeed a capital endowment; but the difeases of the alimentary tube, with their endless train of symptoms and consequences, are the immense price we pay for it. Upon this view of the comparative structure of plants and animals, it would feem that we should examine the kinds and qualities of food in the latter, in order to ascertain the causes of those complaints to which they are peculiarly subjected. And here it happens, we have a most striking and instructive saft to guide us. Mr. Verdoni declares, "that the, "Greek christians in Smyrna, during the sea," fon in Lent, when they eat only vegetables, are "very seldom attacked by the plague; while "among those who eat flesh, the contagion makes "great havock. Hence the hest means of pre-"vention are to eat moderately, and not at all "of animal food, &c." And I believe a multitude of safts tending toward the same conclusion, could easily be collected.

The cause of plague, and consequently of other analogous severs, would seem to reside then, in the animal part of the ingesta; and so, according to the theory, it ought: for, from that source should flow the azote, or base of the gaseous oxyd, the cause of the most alarming and dangerous symptoms accompanying this

class of distempers.

It is a fact worthy of particular regard, that the two cases of contagion caused by the gaseous oxyd, one produced from external causes, contaminating the air, and affecting the lungs and respiration, and the other arising from circumstances existing within the body itself, and disturbing the stomach and intestines, should have been distinguished by Hippocrates. In his book, De statibus, he, with great sagacity, notes the "aër" operating without the body, and the "spiritus" acting within, and both of them causing severs; to the former he ascribes epide-

mics, where, from a change in the qualities of the air, many persons are incommoded, as in pestis; to the latter, he attributes spendies, where, from bad diet, flatulencies proceed, creating dis-

turbance in the whole animal frame.

There are four facts concerning the alimentary mass which impress the mind with the belief of the actual extrication of the gaseous oxyd in the primæ viæ. First, The production of a gas is manifested by tension, oppression, and belching, as unequivocal figns denoting wind, distending the bowels. Secondly, On some occasions, there is a vomiting of black matter, which confifts frequently of extravafated blood; this tends to determine the gas to be of fuch a fort as to afford no oxygene to the blood, which therefore requires no floridity. Thirdly, The existence of green stools, in certain stages of the difeafe, point with more certainty to this oxyd as their cause, particularly since it has been obferved to tinge both water and glass of a remarkable green colour. And fourthly, There is no instance related of persons afflicted primarily with this malady, except flesh-eaters.

A fource of poisonous effluvia thus seems to exist in our own bodies, sufficient to disturb the animal machine excessively, and even to effect its destruction. There can hardly exist a doubt, that the great quantities of butcher's meat, poultry and fish which we consume, are the materials which chiefly afford the gaseous oxyd, and that in our choicest viands, we swallow down the principle of sickness and decay. The session of slaughtered animals, prone in hot were

ther to enter upon an incipient putrefaction, may, in fome cases, not meet with a sufficient corrective in the stomach, and pursuing its propensity there, may go on to rot and rot, and induce, by its mischievous productions, the

most calamitous consequences.

It has been long ago doubted, by confiderate and humane persons, whether man was justifiable in preving upon his fellow animals. The authority of revelation, added to the make of his teetli, and the conclusions of reason, have decided in favour of his right. But how far this indulgence, or luxury, for animal food can scarcely be called a necessary of life, may be gratified, is left wholly undetermined. Our own experience alone, of the wholesome or pernicions effects resulting from its use, must guide us. Judging by this, there appears a phyfical certainty, that we devour more of it than does us good; nay, that in the enormous destruction of animal matter, raifed in fuch abundance for our riot and gluttony, fome of the most ferious of bodily evils are generated, and these particularly in cities, camps and ships, badly regulated. The causes of such distempers are deeply founded in our state of society and way of life, and as long as we gorge ourfelves with animal food, and dwell among its putrefactive recrements, the poisonous gaseous oxyd of azote proceeding therefrom, must be expected to disturb both our respiratory and digestive sunctions, and be sollowed by scenes of diffress and woe.

3dly. Provided, the oxyd should be produced during the disorganization of the food, &c. in

the alimentary canal; what changes will it bring about in the chylopoetic vifcera, and what fymptoms excite in the conflitution at large, particularly in those who at the same time in bale more

or less of it into the lungs?

No person acquainted with the mode in which the animal body acquires its heat in the lungs, need be informed that, in a case where the gaseous oxyd has, in a dilute form, been breathed, and from the fituation and circumstances of the patient continues every moment to enter the trachea, the fymptoms will be very different from those of a person whose respiration is free from contagion, but has the noxious gas in his bowels merely. It is therefore to be carefully confidered, that according to the na-ture and function of the organ on which the gafeous oxyd exercifes its virulence, will there be a variety in the morbid fymptoms, though produced by the same cause. If, for instance, the stomach and the intestines are the feat of the gaseous residence, inflammatory symptoms of those parts, with tension of the præcordia, dryness and redness of the fauces, great heat and high pulse may be expected to supervene;whereas, if the lungs are pervaded by it, the heat will be moderate, the countenance pale, purple, or yellowish, the pulse flow, and the first passages more quiet: while the most violent diseafe must ensue, when both the lungs and intestines are exposed to its virulence.

1. Let its effects upon the stomach and bow-

els be attended to.

Costiveness is favourable to the production of

this gaseous oxyd, by retaining the seces an inordinate length of time, and preventing the ready escape of the flatus. Accordingly, it is related, that in the bilious yellow sever of Philadelphia, which prevailed in 1793, (Rush's Account, &c. 52.) "the bowels were generally "costive, and in some patients as obstinately so "as in the dry gripes; and flatulency was an "almost universal symptom in every stage of "the disorder."

From its qualities, as mentioned before, we are at no loss to explain the painful burning which fometimes occurred before any vomiting took place, and the gastrodynia which at times ushered in the disease. Nor, when we consider the irritated or instanced condition of the parts, can we be at a loss to understand wherefore it feldom appeared without nausea and vomiting, and why that vomiting was sometimes so long

continued, violent and convultive.

The inflamed state of the stomach and duodenum, and other parts of the intestinal tube, in all cases of dissection after death, and the black, gangrenous and mortised spots found thereabout in numerous instances, are just such as might be expected from the operation of a gas so deleterious as the azotic oxyd, which in some cases of high malignancy may be imagined to acquire by union with a larger portion of oxygene than common, an uncommon degree of activity, or acrimony as it is called; in its effects, resembling in every particular that condition induced by the oxyd of arsenic.\*

<sup>\*</sup> It is remarkable what an analogy there is be-

The coffee-coloured, grumous and dark matters ejected from the stomach, are probably in a great measure derived from the sanguineous stuid, blackened by contact with the gas, and effused from the vessels ruptured by its erosion or causticity. Some part of them may consist of bile vitiated by the same cause, and of putrid ichor proceeding from the gangrenous spots.

Excoriations of the rectum and external termination of it, correspond to the inflamed state of the superior portions of the intestinal canal,

'and

trueen this oxyd of azote and metallic oxyds. Azote, as well as the metals, in its pure state has little or no chemical operation upon the body: as foon, however, as they become oxydated, they acquire activity; and that this activity is proportioned to the quantity of oxygene they absorb, is sufficiently evinced by the preparations of antimony, ar senic and quickfilver. There is another trait of character in which azote resembles arsenic and some other metals, which is, that they are both acidifiable bases: as by increasing the quantity of oxygene, you change the oxyd of the metal to an acid, possessing powers greatly superior to what it possessed before, so, by giving the oxyd of the gas a larger dose of the acidifying principle, you increase its activity to an extreme degree. There is thus a very strong chemical analogy between the exyd of azote, and white arfenic. Perhaps azote is a metal. Quickfilver is a metal, maintaining fluidity under the common circumstances of terrestrial heat and atmospherical pressure. May not azote be a metal existing in the same circumstances of warmth and weight in a vaporific form?

and are fairly ascribable to the same cause; as is

also the hiccuping.

In a word, the pain in the fides, and in the regions of the stomach, liver, and bowels, with their hotness and spasms, and with the consequent distress both of body and mind, all indicate the locality of this malady, as well as point to the nature and cause of it.

There is one case which may be imagined to happen, in which the stomach and bowels are disturbed by the gaseous oxyd swallowed with the spittle and the food. Where the oxyd is abundant, it can easily be understood from its disposition to unite with water, that some part of it may attach itself to the shuids of the mouth, and be swallowed; as also forming a connection with the alimentary mass in the act of chewing, may, together with it, descend into the stomach; and thus, in either case, produce its harmful effects.

2. Its operation upon the lungs shall be next

inquired into.

If a full infpiration of the gaseous oxyd be made, there will be a sudden extinction of life; and this accordingly accounts for the fact related by Russel, (History of Aleppo, p. 232.) and confirmed by other observers, of many persons falling down dead suddenly, when struck with the contagion of the plague.

If a quantity of the same fluid be mingled in fuch proportion in the atmosphere, as by its dilute state to produce neither immediate death, nor catarrhal affections; then the slow and undermining effect of it, by constant breathing, will

(C)

be manifested, first in the fighing, anxiety, tossing of the body; afterwards by languor, faintishness, coma; and afterwards by the sleep-like and

gentle approach of death.

An inhalation of a more condensed or concentrated oxyd will account for the pulmonic symptoms sometimes occurring, give rise to pain and convulsions, and lead to an explanation why, after running a certain length, they should suddenly end in effusions of blood or other sluids to stop the respiration entirely.

I am fatisfied, from experiments repeatedly made upon myfelf and others, that the heat of the body and beat of the heart and arteries are, to a certain degree, under the government of the will. This depends upon their connection with the respiratory organs. If, while all the other voluntary muscles are at rest, breathing be quickened by an effort of the will, the action of the heart and arteries will be increased, and so will the heat of the body; if, on the other hand, a person sitting as quiet as possible in a chair, inspires the smallest possible portion of air that he can, without bringing on anxiety, and continues to do fo for fome time, a thermometer placed in the arm-pit will fall feveral degrees, and the pulsations of the heart and arteries be exceedingly diminished in frequency and force. I mention these experiments to show how intimate the connection between respiration and the circulation of the blood is in the most healthy state of the body, and how the latter is governed by the former. The heat of the body is nearly, other things being equal, in proportion to the oxygene gas decompounded in the lungs, and so also is the force of circulation from the stimulant quality imparted to the blood. If the air inspired be mixed with a large quantity of non-respirableair, then, though a full inhalation be made, there will be but a small portion of vital air decompounded, and, as in the case of voluntary diminution of the breathing, the heat must be lessened, and the contractions of the heart be more flow and feeble. It can easily be understood then, wherefore in some cases there should be weakness of pulse; in others, no uncommon quickness or frequency; in others again, such lowness that it can be hardly felt. We hence are enabled to understand why the pulse sometimes intermits, and to account for that remarkable flowness, which, when confidered in this point of view, indicates extremest danger; while, according to the ordinary way of judging, it has been confidered as denoting that there was no fever: and the justness of this interpretation is confirmed by observing, on diffection, the blood in the heart refembling, in its qualities, the blood of persons that have been hanged. The coolness of the fkin and the coldness of the limbs are in this manner very naturally accounted for.

In certain cases of high malignity, the bodies of patients dead of sever caused by this gaseous oxyd, have been all over disfigured with purple spots, and have even sometimes assumed a blackish hue. Yea, even during life, vibices and blackness are known to make their appearance, and when they do, to be attended with cold-

C 2

ness prevailing in the livid parts a day or two before death. These appearances are entirely explicable upon the idea, that the lungs are filled with a species of air, not capable of oxyganating the blood, carrying away its carbone, and imparting heat to the body. The case described by Huxham, in pages 98 and 99, is a very instructive one, and illustrates this doctrine in a forcible manner; as does the case described by Sandifort. (Obs. Anatom. Pathol. 11.)

From a review and confideration of the hiftery of fuch cases, it would appear there was a fewbutic habit of body induced, and that the hæmorrhagies, debility, and prostration of strength, as well as the darkened colour of the blood, and the want of cohesion in the solids, might be all accounted for upon the same prin-

ciple in fever as in scurvy.

It very foon occurred to me, if my idea was just, that the gaseous oxyd ought, when in a concentrated form, and approaching the state of an acid, to manifest itself by corroding metallic substances. On inquiry, I found sacts of that kind on record; for Van Swieten relates, "that in the plague of Oczakow, the silver hilt of a "fword, which all the time of the plague hung "up in a tent, was changed quite black: and "the instruments which the surgeons made use of were turned as black and livid as if they had been dipped in aqua fortis," (nitrous acid.) (Comment in Aphor. Boerhaav. § 1407.)

Upon discovering this, I became convinced, that if my conjecture was right, a substance so active as the gaseous oxyd ought, when applied

to the skin of well persons, to excite disorder there, and this I found to be true: for Van Helmont (Tumulus Pestis, p. 853.) saw a man, " who, upon touching some papers infected by "the plague, felt instantly a pain like the prick " of a needle; a pestilential carbuncle made its "appearance foon after on his fore finger, and he died in two days." A man who stirred up with his foot the straw whereon the bed of a person sick of the plague had been laid-" a "little while after he felt an acute pain in the "lower part of his leg, just above the foot, as if "the part had been scalded with boiling water; "the next day the epidemis or scarf-skin was "elevated into a large blifter, upon breaking " which, a quantity of blackish liquor run out, " and underneath, a latent pestilential carbuncle " was discovered, which could hardly be cured " in a fortnight." (Van Swieten, § 1409.)

There was another inference from my principle upon which I laid fo much stress, that if it had not turned out according to my prediction, I should have given up the whole matter as visionary. This was the effect that air of the kind I had in contemplation should have upon brute animals of the domestic kind. Thus Sorbait of Vienna (quoted by the last mentioned author) says, that during the plague, "larks, so numerous in Austria during the austrem, were wholly wanting, so that not a single one could be met with; and tame birds kept in cages all died." Homer mentions the death of dogs and mules as the forerunner of the pestilence in the Grecian camp before Troy.

(Iliad i. 69.) The pernicious and deadly effects of the atmosphere during the plague at Athens, in the second year of the Peloponnesian war, upon birds and beasts, and particularly on dogs, is mentioned by Thucidydes\* (B. ii.) Boccace, in

\* The disputes concerning Epidamnus and Corcyra had for some time agitated the governments of Corinth and Athens. These dissentions, founded chiefly in a jealoufy of the growing and encroaching power of the people of Attica, furnished sufficient pretexts for most of the states of the great Peloponnesus, to join in a confederate war against them. In the 431st year before Christ, the war began between the Peloponnesians and Athenians, and their confederates on both sides. That more vigorous preparation might be made for war, Pericles advised the Atticans to move from their country residences to their chief town Athens. His advice was followed. They fent away their flocks and labouring cattle into Eubæa and the adjacent islands, tore down their houses, and with their wives, children and furniture, for rowfully moved from the open country, where they had been accustomed to live, to their metropolis. Great inconveniences were now experienced by them, especially since that, after regaining the waste committed by the invasion of Xerxes, the inhabitants had established themselves in a most comfortable way of living. After moving, they were obliged to adopt a new mode of life: few had houses ready for their reception: some sheltered themselves with their friends and relations: the greater part were forced to settle in the less frequented quarters of the city, in the buildings facred to the gods and herces; and many were even obliged to lodge

in his account of the plague at Florence, "faw "with his own eyes, two hogs that had rolled "about with their fnouts, and gnawed fome "pieces of bread which had been thrown into "the ftreet from a poor man's house who had "died of the plague, instantly seized with con-"vulsions, and died within an hour after." In dogs and cats the symptoms of plague have actually been known to appear, shewing themselves in the form of buboes, &c. The cats of Philadelphia died in 1793, and it is highly probable

themselves within the turrets of the walls, or whereever they could find a vacant corner. In short, there was a greater number of people than the city could contain, and after the Pelasgic was occupied, the Long-walls and great part of the Piræus were portioned out to them for little dwellings. Thus fent up, the Athenians continued accumulating filth and every kind of noxious matter among them during the winter and until the ensuing summer, when, on the operation of heat, the gases were volatalized that brought on the memorable sickness, which has been called the plague of Athens. The attempt of THUCIDYDES, to trace it back to Lybia, Egypt and Æthiopia, is wholly unfatisfactory, and just as groundless as our own endeavours at present to prove yellow sever always imported from the West-Indies or some other foreign place. The causes of the plague at Athens, which was, in fact, only a very bad yellow fever, existed among themselves, just as they do among the New-Yorkers and Philadelphians now-a-days. A truth fo plain and fo important as this is, ought to be candidly received by every citizen of the United States.

bable their deaths are to be in part ascribed to

the gas they breathed.

Again, if the idea I entertained was well founded, the gafeous oxyd ought, when very concentrated, to shew its capability to support flame. The two following facts, though not related with fusficient accuracy or distinctness, are however cases in point, and as far as they go, illustrate and confirm the doctrine in a forceable manner. The first is, "that a light-" ed candle being held near dving persons, a " very livid vapour was feen to iffue from their " mouths." The other, the relator fays, he frequently observed in the form of a blue smoke, as it were, in the rooms where the infected lav. (Van Swieten, § 1407.) Now, when these facts are compared with what Priestley describes of a candle burning in the gafeous oxyd with an enlarged flame, by another flame (extending every where to an equal distance from that of the candle, and often plainly diftinguishable from it) adhering to it, and in some of his experiments burning blue, there appears to be considerable similarity in the cases.

Moreover, knowing that under an atmospherical pressure, which supports the quickfilver in the barometer at 29.84 inches, and in a temperature of 54.5 of Farenheit's scale, a cubit soot of azotic gas weighed one ounce thirty grains and one half; and of oxygenous gas, one ounce one dram and fifty-one grains; it was presumable that a combination of the two, that is, thirty-seven parts of oxygene united with fixty-three of azote, would form a fluid of near-

ly the same weight with atmospherical air, or rather heavier, and the probability of this would increase, by considering that a cubic foot of nitrous gas, which contains only thirty-one parts more of oxygene than the gafeous oxyd does, weighs one ounce two drams and thirty-nine grains. An inference from this is, that perfons who refide in low fituations, where the gafeous oxyd is generated, or patients who lie near the floors of infected chambers, ought to fuffer more than others, by reason of their breathing an atmosphere more loaded with non-respirable vapour, tending downward on account of its weight. This inference from the principle is also conformable to fact, fince it is known both in New-York and Philadelphia, the lower parts of the city have been most severely afflicted, and that phyficians, friends, nurses, &c. who walk erect in the chambers of the decumbent fick, escape danger, and breathe a tolerably pure air; while the unhappy patient, laying near the floor, toward which the heavier oxyd fettles, inhales deadly gas at every infpiration.

Again, it was clear to me from the little dif-

Again, it was clear to me from the little difposition the gaseous oxyd possesses to combine
with other bodies, and, from its considerable
weight, that it might be transported from place
to place, in tight boxes or packages of goods,
&c. and that, on opening these, and taking out
their contents, the unchanged gas might be inspired into the lungs, or infinuate itself into the
stomachs of such persons as should be exposed
to it. This inference from the principle is also
conformable to sact; for upon it depend the in-

ftantaneous deaths in fome cases; transported infection in others; and severs kindled up in others, from the subtil matter exhaling from tuch somes.

Befides, if, from the heaviness of the oxyd, it always has a tendency to the lower parts, then ships, through whose sides it cannot leak out by reason of their tightness, should be very apt to accumulate it; and this too corresponds with the fact; sea-vessels being among the chief agents in its production and disfusion, the receptacles of its collected virulence, and the seats of its most destructive ravages. Cellars are noxi-

ous for the same reason.

It must be obvious, that the symptoms of these febrile diseases, excited by the gaseous oxyd, are divisible into two classes. Sporadic cates may occur, in which, from its production within the body, the stomach and bowels may chiefly labour, and in these will the symptoms first enumerated prevail, attended with high excitement of the fystem. Endemic sickness may generally be expected, when, from an extrication of the gas in large quantity from fome abundant fource without the body, the contagion operates upon the lungs, and produces the fecond class of symptoms, and in these will the pulse be flow, and the heat moderate. The worst cases that can occur will be those, where, both from external and internal causes, the stomach, and lungs, and skin, are attacked at once, and afford a mingled assemblage of symptoms.

There has been much dispute about the production of contagion, whether from animal or

vegetable

vegetable matter. The controversy seems to me to be a trifling one. It is understood from analysis, that the bodies both of plants and animals are composed of the same elements or principles, vaying in their proportions, structure, &c. It is known for instance, that oxygene, which constitutes 37 th parts of the azotic oxyd, is very plentiful in most vegetable substances, and that some of them also contain a portion of azote, the ingredient forming the other 63 th parts. In such cases there can be no question, that the oxyd might be produced during their decomposition. It is likewise known, that animals contain a very great proportion of azote, and mostly a moderate quantity of oxygene. There can be hardly a question then, that the oxyd might be generated from decaying substances of this fort. But as the one substance is highly charged with oxygene, and the other with azote, the mixture of the two feems most likely to afford the greatest amount of oxyd, and this, I believe, is agreeable to fact. Pure animal matter will therefore perhaps be less likely to afford this oxyd than a mixture of it with vegetable. This explains why the stomachs of living perfons, containing commonly a mixture of the two kinds of food, and the abdomen of dead bodies, are so prone to the production of it; and why flaughter-houses, tan-vats, curryinghouses, works for making glue and Prushan blue, the horner's business, oil shops, and manufactories of foap and candles, are not remarkable for generating contagion. There is very little acescent vegetable matter employed there, and confequently the gaseous oxyd is sparingly formed. On the other hand, in vinegar cellars, wine presses, cyder mills, and other places where much unmixed vegetable matter of the oxygenous kind is accumulated, no inconvenience arises, as there is little azote to join in producing the oxyd. I see, however, no improbability in the idea, that independent of animal and vegetable matter at all, there may exist in nature some mode of combining oxygenous and azotic airs. But I know of no such process at present.

This inquiry has brought contagion home to our doors, and traced it to its feat within our bodies. Henceforth much of the labour employed in tracing the origin of fevers in foreign places, and their introduction in ships to our own ports, may be considered as superstuous.

Causes enough exist among ourselves, at certain times, to engender the most noxious vapours. The study of the production, and diffusion of these from domestic and internal sources, should most assiduously engage our attention. In doing this, we shall be employed in earnest, in counteracting as well as detecting this wide-spreading and terrible evil.

On this head I shall first speak of prevention,

as it respects the stomach and intestines.

According to the theory delivered, the perfons who live on vegetable food, or keep a lax belly, ought to have no disorder, or a very slight one. This conclusion is confirmed by facts in abundance. The advice given by the Arabian physicians to prevent the plague, en-

joins the repeated use of acid fruits, as pomgranates, Seville oranges, lemons, tart apples, &c. but above all wine-vinegar in small quantities, &c. (Mead on the Plague, chap. ii.) Doctor Wade has established the efficacy of a vegetable diet, (Rush on Yellow Fever, 334.) and of water as a drink, as the best means of preventing the yellow fever in a hot climate. Mr. Howard has borne testimony of the benefit of low diet as a preventative of the plague; and it is reported, that during the famous plague described by Thucidydes at Athens, Socrates the philosopher preserved his life by means of slender diet, as did Justinian at Constantinople in a similar case, by his abstinent way of living. The avoiding of animal food, adhering to a low diet, and taking laxatives, was doubtless one of the means of preferving the life of Dr. Rush, during the late calamity in Philadelphia; and what may ferve as a host of facts, in a word, it is related by Bontius, that the plague has never vet shewn itself among the natives (rice eaters) of the East-Indies. Speaking of China, Dr. Mead fays, "We have no instance of the plague " that was originally bred in that country."

Here then, we have evidence of such an extensive and conclusive kind, as to satisfy even the sceptical mind concerning the ease and possibility of prevention. By avoiding animal food, azote is kept out of the stomach, the destructive gaseous oxyd is not formed, nor are the instanmatory torments of the bowels selt. By keeping an open belly, the plan of securing the health will be promoted, and no detention

of feculent matter give rife to flatulency and oppression. I doubt whether the metallic rod will more securely guard us from lightning, than vegetable sood preserve us from pestilence.

As to the fecond head of prevention, as it regards the production of the gaseous oxyd in quantity sufficient to contaminate the air and injure the thoracic viscera, it forms so interesting a branch of general police, that it is needless to remark any further upon it than to say, while puddles of putrid nastiness, and piles of reeking dung are incessantly exhaling their poisonous steams, that magistracy consults very imperfectly the public health, which reglects the removal of such common nuisances. The city, as well as the individual citizen, wants a cathartic now and then; and by this plan, and by changing animal for vegetable food in the summer time, a world of sickness and mortality might be prevented.

In the case of gas already produced, and pervading the rooms of a house, or the houses of a neighbourhood, as it is formed by a chemical process, it may be very rationally demanded, whether, by some chemical operation, the gaseous oxyd may not be decompounded? It has been already stated in the history of the substance, that it resisted decomposition by sulphur, phosphorus and caustic alkali entirely; was but feebly attracted by charcoal; and that hydrogene was the only substance as yet known, having a powerful affinity to it. In what form

this can be applied so as to separate the oxygene from the oxyd, and leave the naked azotic gas in the possession of its ordinary harmless qualities, is a field for curious and useful inquiry.

Long ago has it been remarked, that our

Long ago has it been remarked, that our vices were the parents of our misfortunes. Never perhaps was fentiment moreforrowfully verified than in the present instance. Our luxury and session the inhabitants of air, earth and water to death; and it seems as if, in revenge for our cruelty, this tormenting spirit had arisen from their graves to plague us.

HITHERTO we have been ignorant of the precise nature of contagion; but since we are become acquainted with its production and composition, it is very much in the power of individuals to guard themselves against it, and for magistrates to protect cities from its ravages. To what extent the principle now started may be carried in explaining other diseases, is not eafy to imagine. One can hardly suppress the conjecture, that the same poison which in a costive habit of body causes inflammation of the stomach and dreadful fevers, will, in a lax habit, occasion cholera or diarrhœa, or in case habit, occasion choiera or diarricea, or in case the large intestines be obstructed, terminate in dysentery. How far it may, when operating on the lungs, concur in producing influenza and scarlatina, is an interesting question. And this is particularly worthy of our notice, from the reason and analogy of the thing, independent of the very remarkable and impressive fact related by the elegant and judicious author of the account of the yellow fever in Philadelphia in

1793, who tells us, (p. 6.) that cholera, remitting fevers, defentery, influenza and fearlatina were the immediate forerunners of the disorder he describes; and that, "in the course " of a few weeks, (p. 89.) they all disappeared " or appeared with symptoms of the yellow fewer; fo that after the first week in September " it was the solitary epidemic of the city." The case of the girl immediately sollowing this quotation proves the proposition I am contending for to a demonstration. There is reasonable subject of inquiry too, how far phthiss in hot climates, and scrophula, may be derived from a like source.

The connection of this fever with other complaints is strikingly exemplified in the following narrative: (Anson's voyage, fol. p. 131.) But, (speaking of scurvy) says Mr. Walter, "it " is not easy to complete the long roll of the " various concomitants of this disease; for it " often produced putrid fevers, pleurifies, the " jaundice, and violent rheumatic pains, and " fometimes it occasioned an obitinate cof-" tiveness, which was generally attended with "a difficulty of breathing, &c. &c. At other "times, the whole body, but more especially "the legs were subject to ulcers of the worst "kind, &c. &c." The evidence of analogy, too, strongly favours the opinion, that other contagions and poisons may confist of the same materials, varying but in their proportions, or in some unimportant circumstance, and that the virus of syphilis, small-pox and measles, and of the spider, rattle-snake, and other venomous creatures, as being all of animal production. duction, may confift in the main of azote and oxygene, combined perhaps with some other ingredient: and there is high probability that marsh miasmata will be found little else than a similar compound. The ichor of cancer and other corroding ulcers is very probably pretty much the same thing. The disease of rabid animals, and the dread of water and other miserable symptoms consequent upon their bites, may very probably receive some light from this source; and so perhaps may sibbens, yaws, and leprosy.

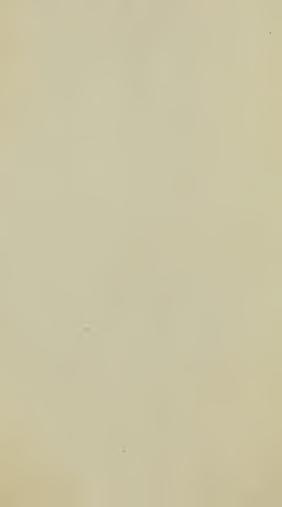
We have confidered already what varied fymptoms may be caused by the same matter operating upon different parts of the animal frame. In all probability much of the difference observable in the operation of different poisons, arise from the sensibility, irritability, structure and function of the part to which it is applied. This idea at least feems to be countenanced, by what we observe in the syphilitic virus, which, when applied to a fecreting furface, causes gonorrhœa; toa dry one, chancre; to a glandular furface, bubo, &c. who knows but a similar exciting cause may, by operating upon the constituion, in one way, produce continued, in another remittent, and in a third, intermittent fevers, which in reality differ from each other less in their causes than in the particular part of the body to which this cause is applied? The difference of the feveral fevers brought on by this gafeous oxyd being chiefly connected with the vifcus or function injured by its action, it is to be understood, that if the liver is invaded, this may induce, according to circumstances,

an impeded fecretion of bile, and then there will be a fever without yellowness, or an obfiruction of the gall-ducts, when, from an abforption from the fecreted fluid, there will be yellowness tinging the eyes or skin, or a vitiated fecretion, appearing in the form of a green or brown matter vomited up. In like manner, when the lymphatic system is the feat of its action, it may cause buboes in the glands; or when the skin is beset by it, carbuncles, fores, and miliary and petechial eruptions may break out. So likewise in the mouth and sauces, aphthous ulcers, and erysipelatous inflammation, a spreading perhaps of the original malady in the stomach, may all derive their origin from the same cause.

This method of considering contagions is entirely conformable to the simplicity of nature. The assignment of a multiplicity of causes, to account for particular phenomena, always betokens a backward state of knowledge. The business of science is to generalize facts, to class phenomena under distinct heads, and show their dependance upon a common principle or cause. Accordingly, in the progress of human reason, polytheisin has vielded to the conviction of the existence of one God; the intricate and seemingly opposite phenomena of matter and motion have been referred to one general law of gravitation; the puzzling and diversified appearances of electricity have been reduced to a few plain rules; the multitude of facts concerning light and colours have been in like manner arranged into a scientific form; and both the rainbow and the telescope bear witness to the simplicity of optics. The sluids composing our atmosphere have been analized, and the influence of these, and of many occasional combinations of other substances into gases, upon life and health, been investigated to their principles. Contagion alone has remained a subject for doubting and guessing; a dismal somewhat, whose exact origin was unknown, and whose operation seemed capricious or unaccountable. This, I trust, will now, like other agents in creation, be found to have its laws of production, disfusion and action, which are steady and unvaried in their nature, as well as simple and easy to be comprehended.

I was going into the practical confiderations and directions refulting from the principles laid down; but the subject was so extensive, and materials slowed in upon me so fast, that the work would very speedily have extended far beyond the bounds I had now prescribed to myself; and impressed as I was with the extensive and beneficial application of this dostrine of contagion to every place upon earth where it is generated, and to every constitution upon which it acts, I selt a deep concern to make it public

as foon as I conveniently could.



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